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EXPERIMENTAL STUDY OF SLAB Nd, YAG LASER

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The major results of an experimental study of a slab Nd: YAG laser are reported in the article; the laser was successfully developed by the authors. The major findings include the following: (1) method of cooling the blended flowing air and water, as well the related experimental parameters; (2) by using a crossed lens cavity, the authors further improved the anomalous capability within the compensation cavity of the slab laser, as well as higher insensitivity of the system to maladjustment; and (3) processing technique and major points of slab YAG laser medium.

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LASER PROPERTIES OF (Nd, Ce): YAG CRYSTAL

Sun Hongjian, Liang Zerong, Ying Zuoqing, Zhang Shengxiu, and Zhai Qingyong, Southwest Institute of Technical Physics; Zhang Enyuan, Wang Qingyuan, and Wu Shiyue, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

Jointly developed at the Southwest Institute of Technical Physics and the Changchun Institute of Applied Chemistry, the (Nd, Ce): YAG crystal has the following properties: (1) high efficiency, low threshold value with application of an OD5x80mm crystal rod; a xenon lamp was applied in an ordinary light focusing device. When the input energy was 10J, the static laser point efficiency was 3%; the slant efficiency was 4%; and the laser threshold value was approximately 1.5J. The crystal had a 60% higher point efficiency, and an approximately 1J lower threshold value, than the Nd:YAG rod (OD5x76mm with unified number H510), which was awarded a prize at the 1986 All-China Competition. (2) The crystal has the capability of resisting

ultraviolet radiation, and is free of any ultraviolet effect when a conventional quartz lamp pump is used; when the input energy was 19.2J and 10,000 pump cycles, the energy output of the static laser pulse did not decrease. (3) When grown in a resistance furnace, the (Nd, Ce): YAG crystal was free of attenuation of the static state laser pulse energy.

Since the crystal has properties of high efficiency and low threshold, the input energy can be considerably reduced when used in intermediate- and low-power devices, thus rapidly reducing the heat produced by the pump. Therefore, only by using air cooling can the repetition frequency 10 to 15pps be realized. The energy output of the unadjusted Q laser pulse is approximately 200mJ (the input energy is 10J).

When this air-cooled laser was placed in an enclosed box and heating it with a small electric furnace to raise the box interior temperature to 140C, under these conditions the unadjusted Q laser pulse energy for the (Nd, Ce): YAG air-cooled laser with repetition frequency 10pps did not appreciably decrease. (This experiment was conducted by Deng Chongjun of Institute Number 209.)

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PROPERTIES OF DUAL-WAVELENGTH MODULATED LASER RADIATION WITH MIXED DYES

Lei Jie, Xue Jun, and Fu Honglang, Department of Physics, Yunnan University

The article reports on an experimental study on generating dual-wavelength modulated laser oscillations in a solution of mixed dyes coumarin 1 with the addition of rhodamine 6G, rhodamine 6G with the addition of cresol purple, rhodamine B with the addition of cresol purple, as well as rhodamine 6G with the additions of rhodamine B and cresol purple-ethanol solution in the presence of N_2 pumping. The authors analyzed the dynamic

process of the dual-wavelength modulated laser in mixed dyes, and investigated the variation in dual-wavelength laser radiation intensity with dye concentration of the receptor in the mixed dyes, and also investigated the modulated wavelength region of the dual-wavelength laser for several mixing concentrations.

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METAL HARD SEALING TECHNIQUE FOR GERMANIUM WINDOW IN A LASER

Lian Jianxue and Liu Lingmin, Southwest Institute of Technical Physics

The metal hard sealing technique for the infrared window material germanium in gas lasers employs a heat-melted high-melting-point metal to vacuum seal the germanium chip over the laser tube opening. The gas leak rate of the sealed surface is less than 10^{-12} Torr·L/S. Moreover, the seal can withstand high temperature shocks at 400C without change in optical properties of the germanium lens. The physical strength of the seal between germanium chip and the laser device tube opening is higher than for germanium proper.

This technique solves the problem of degassing by baking in the tube-fabrication process, and also provides a means for sealing infrared window openings in laser devices in a high-temperature environment. With this technique, the authors successfully carried out hard sealing between a germanium lens and the ceramic tube opening of a TEA CO_2 laser. This technique can also be applied in vacuum sealing of infrared window openings in other vacuum devices (such as infrared heat imaging instruments); the tube opening material can also be made of metal. By vacuum sealing and baking of the optical window opening in the case of glass, as well as germanium and a glass slide is a mature, practical vacuum sealing technique.

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HIGH-POWER DENSITY LASER RADIATION EFFECT

Guo Zhenhua and Xu Desheng, Laser Technology Laboratory, Central China University of Science and Engineering

Under a high-power density laser radiation, the article describes the mutual acting mechanism and experimental apparatus between light and matter and also analyzes the intensive light beam self-trapping phenomena and the excited Brillouin scattering effect, the non-phase change heating process when intensive light acts on opaque matter, the particle emission (mainly the dual photon absorption emission) acted with intensive light, and gas puncture (such as inert gas argon) subjected to intensive light. The article discusses in detail the requirements on laser beam quality, power and power density in experiments, and the various layouts of the measurement apparatus, and technical treatment of various specimens and specimen housing. The experiments demonstrated the breaking and damage phenomena in some materials and preliminarily analyzed the following causes of the actual process that occurs: (A) with the superimposition of the phonons by excited waves generated in Brillouin scattering, an intensive mechanical force smashes the specimen causing it to scatter. (B) The microdefects of material phi first form heat-absorbing centers leading to heat impact generated by a very high temperature gradient with the addition of a microzone heat plasma on the specimen, causing its destruction. (C) Thermal melting causes deformation. (D) Superimposition with electron collapse and heat melting effect causes the material to disintegrate. (E) Superimposition between the mechanical force disintegration of excited wave phonons and the heat absorption effect causes material breakdown. All these effects have a certain reference value in preventing damage to laser devices and optical systems,

atmospheric transmission and other specific targets.

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RESEARCH ON Ti-C LASER ALLOYING AT THE SURFACE OF TYPE 60 STEEL

Zhang Enyu and Zheng Kequan, Department of Physics, Lanzhou University

Surface alloying with a laser can be utilized in controlling the parameters of laser treatment techniques, as well as the composition and proportions of the elemental powder alloying additives, thus forming an alloy with the required composition on the material surface. With this technique, a high-property alloy layer can be formed on the surface of conventional inexpensive steel; this is a surface intensifying method with outstanding results.

In this article, type 60 steel is used as the substrate; blended TiO_2 and C powder blended in a given proportion were dissolved in an organic solvent for coating on the substrate. A high-power CO_2 laser was used by selecting the appropriate laser treatment parameters in conducting rapid melting condensation treatment on the specimen surface, with the following major results:

1. There is cellular crystalline structure as the texture of the alloyed zone; the components of the alloy layer are distributed uniform macroscopically along the longitudinal and lateral direction constituents of the lateral cross section, and the constituents increase with increase of coating layer thickness for the alloy components with the same scanning speed; when the scanning speed is changed, the components of the alloying elements in the alloyed zone are changed.

2. From an X-ray analysis of the results of substance phases, the phase constituents of the alloyed surface layer are as follows: diffusion distribution of multiple hard-substance phase compounds (such as, alpha-Fe, gamma-Fe, Fe-C, Fe_3C, Fe_2C, Fe-TiO and TiC) has an important function in strengthening the alloy layer.

3. With the appropriate laser treatment conditions, alloy layer hardness can be higher than HV1800; moreover, the grinding wear resistance was also improved markedly over that of the substrate.

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STUDY OF TEXTURE AND PERFORMANCE OF C-W-Fe LASER MELT COAT ON THE SURFACE OF TYPE 45 STEEL

Zheng Kequan and Zhang Enyu, Department of Physics, Lanzhou University

This article describes the C-W-Fe melt coat experiment on the surface of type 45 steel by using a high-power CO_2 laser; observations, measurements and tests were conducted on the distribution of the microscopic texture and the melt coat elements, as well as the mechanical properties of the laser melt coated layer. The results are as follows:

1. The microscopic texture of the melt coat layer is that of typical of ledeburite; minute particle compounds of WC or Fe_2W are diffusely distributed on the area surrounding the ledeburite. The main phase compositions of the melt coat layer are: alpha-Fe, gamma-Fe, Fe_3C, Fe_2W (epsilon phase) and WC.

2. As indicated by analyzing the microscopic texture and the elemental distribution in the substrate-melt coat layer transition, there is a junction zone of 5 to 10 micrometers

between the substrate and the alloy melt coat layer with good metallographic merging.

3. The hardness distribution curve is of the typical three-level trapezoidal shape; the hardness of the melt coat layer is higher than HV1700; the grinding wear resistance is nearly 20 times higher than that of the substrate.

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